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CONSIDERATIONS ON THE TAXONOMIC STATUS OF THE LANCELETS OF THE GENUS *BRANCHIOSTOMA* FROM THE JAPANESE WATERS[1)]

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With Text-figures 1–5 and Tables 1–4

Introducton

The lancelets are generally called by Japanese "*Namekuji-uo*" (*Namekuji*=slung, *uo*=fish); at the same time, however, this Japanese name has been applied also to the single species usually referred to *Branchiostoma belcheri* (Gray, 1847) since about 1922 when the taxonomic discussions on Japanese lancelets were seemingly closed as seen in the historical paragraph of the present paper. The inclusion of all Japanese lancelets in the same single species may be acceptable only when some differences found among the specimens of "*Namekuji-uo*" from different localities in this country are recognized to be of the intraspecific variation. On the other hand, the lancelets from Kiaochow Bay on the southern coast of Shantung Peninsula, North China, were distinguished as a distinct variety in 1936 from the typical form of *B. belcheri*, further it was found that this variety was related closely to the "*Namekuji-uo*" occurring generally along the Japanese coasts except the west coast of Kyusyu Island. Evidently, this seems to request the detailed taxonomic re-examination of Japanese lancelets. The study will need a number of specimens from different localities in this country.

Unfortunately, however, "*Namekuji-uo*" has been becoming rapidly rarer and rarer in Japan in these days, though it ever occurred in some waters so richly that it was taken as a kind of sea foods as well as in China—this is the story when the coastal water was still clean in this country. Thus, it was urged to collect large material from localities as many as possible. The efforts payed by the present author for several years brought here the material consisting of more than 150, inclusive of 15 "giant larvae" and a considerable number of specimens from Amoy. The present material can never be satisfactory, but seemingly this might be the limit of efforts to the present author in these days when the coastal waters are affected heavily by pollution in this country and "*Namekuji-uo*" is disappearing from the former localities recorded. Thus, in this paper it is planned to give the results of close

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examination mainly of the meristic characters on the material after the brief retrospection of the research history of Japanese lancelets.

The present material, one half came from the collections of Tokyo and Kyoto Universities, while the other half from many laboratory collections or private ones. Especially, the actual work of the present studies may be said to be triggered by supply of both living and preserved specimens from Dr. Shin'ichiro Fuse, together with his consistant encouragement, of the Seto Marine Biological Laboratory in the very early stage of the studies. Messrs. Chuichi Araga, Hidetomo Tanase and Torao Yamamoto of the same laboratory, Dr. Osami Tabeta of Shimonoseki University of Fisheries, Mr. Hiroshi Goto of Yuraminato Junior High School, and Mr. Takuya Mori of Toba Aquarium gave the author precious information; and Prof. Eiji Harada and other members of the laboratory gave the author many helpful advices through discussions. Drs. Heizaburo Katayama and Koji Hoshino, and other members of the Mukaishima Marine Biological Laboratory, Hiroshima University helped the author in every way to collect specimens in the waters around that laboratory. To the all gentlemen mentioned above as well as to those who afforded the author every facilities to examine the specimens of Japanese (and some Chinese) lancelets in the collection of their institutions or laboratories, or in their own collections, the author would like to express his hearty thanks. His sincere thanks are due also to Dr. Takasi Tokioka, the former director of the Seto Marine Biological Laboratory, who was so kind to read the manuscript and give many suggestions.

The material examined

The material examined for the present study consists of the specimens included in the following 20 collections.

A. The collection in the University Museum, University of Tokyo, through the courtesy of Drs. Torao Satoh and Kenji Mochizuki of the museum.
   1. Reg. No. 26632: 5 inds., near the estuary of River Miya, Gamagori, Aichi Pref., Mr. Kinroku Taniuchi coll.
   2. Reg. No. 10516: 10 inds., near Tadaumi(?), Mihara, Hiroshima Pref., Mr. Kazuki Sawahara coll.
   3. Reg. No. 1433: 3 inds., Bungo Channel, between Shikoku and Kyusyu, Dr. Matsubara coll.
   4. Reg. No. 1430: 4 inds., Ariake Sea, about 4 km off Tegama, Omuta, Fukuoka Pref., collected on the sandy flat, 15–18 cm deep, Apr. 1, 1904.
   5. Reg. No. 18203: 2 inds., ?Ariake Sea, coll. by Fisheries Experimental Station of Fukuoka Pref.
   6. Reg. No. 13521: 15 inds., Amoy.
   7. Reg. No. 11554: 30 inds., "China".
   8. Reg. No. 15043: 30 inds., "China".

B. The collection in the Zoological Institute, Faculty of Science, Kyoto University, through the courtesy of Drs. Jiro Ikeda and Motoo Tasumi of the faculty.

1. Nineteen inds., Sumoto-ohama, eastern coast of Awaji Island, Feb. 15, 1912.
2. Two inds. dried up completely, Tomo, near Fukuyama, Hiroshima Pref., Prof. Tamiji Kawamura coll.
3. Two inds., Amakusa, Dr. Aida coll.
4. Five inds., Amoy, Mr. Y. M. Tung coll.

C. The collection in Yoshida College of Kyoto University, through the courtesy of Dr. Saburo Nishimura of the college.
1. Six inds., Ariake Sea, 1903.
2. Five inds., Amoy, presented by Prof. Ichisada Miyazaki of Amoy University, May 27, 1923.

D. The collection of Mr. Hisashi Yokoyama, a graduate student of Kyoto University. Thirteen inds., from three stations off Kojima and Toyokuni-zaki, Tanagawa, Osaka Pref., 27.5–35 m deep, sand with shell fragments, mud temp. 18.2–19.8°C, May 1978.

E. The collection of Mr. Shigeki Takamori of the Naikai Regional Fisheries Laboratory.
1. A single ind., Onomichi Strait, Seto Inland Sea, Sept. 20, 1977.
2. A single ind., Onomichi Strait, July, 1978.
3. Eleven inds., Shikanose, Harima-bada, Seto Inland Sea, Sept. 7, 1978.

F. The collection in the Amakusa Marine Biological Laboratory of Kyusyu University, through the courtesy of Dr. Taiji Kikuchi of the laboratory. Ten inds., at "Kyusyu Univ. Invest. Stn. A-13", off Shimabara, Ariake Sea, 50 m deep, shell sand, Dr. Tanaka and Mr. Nojima coll., Sept. 25, 1977.

G. The collection of Dr. Fuse.
1. A single ind., Maruyama, western coast of Awaji Island, less than 10 m deep, 1975.
2. A single ind., Nishiwaki, Sakaide, Kagawa Pref., Mar. 1976.
3. A single ind., near Fukura, southern coast of Awaji Island, 8–9 m deep, coll. by Fisheries Experimental Station of Hyogo Pref., Feb. 3, 1976.

H. The collection of Dr. Tokioka: A single ind., south to Jinooshima Island, Wakayama Pref., 35 m deep, sand, Dr. Denzaburo Miyachi coll., Nov. 19, 1938.

I. The collection of Dr. Minoru Imajima of National Science Museum, Tokyo. Three inds., off the estuary of River Nyugawa, Ehime Pref., Mr. Shinohara coll.

J. The collection in the Seikai Regional Fisheries Laboratory, through the courtesy of Mr. Yoichi Shojima of the laboratory. Two inds., north to Shikanoshima, Fukuoka Pref., 33°50.2'N and 130°14.2'E, 50 m deep; these specimens were described by Shojima in 1974.

K. The collection in the Misaki Marine Biological Laboratory of Tokyo University, through the courtesy of Dr. Michio Shigei of the laboratory. Three inds., outside the inlet of Mito, Misaki, by dredge, July 25, 1933.

L. The collection in the Shimoda Marine Research Center of the University of Tsukuba, through the courtesy of Dr. Toshiki Makioka. A single ind., off Akamatsujima Islet, Nabeta Bay, Shimoda, trawled by Messrs. Nakamura, Ueda,

Suzuki and Dr. Makioka, 12–13 m deep, July 14, 1972.

M. The collection of Dr. Kenji Mochizuki. A single ind., coast of Suma, Kobe, several meters deep, Nov. 1977.

N. The collection of Osaka Museum of Natural History, through the courtesy of Mr. Ryohei Yamanishi of the museum. A single ind., near Uryu-jima Islet, Saizaki, Mihara, Hiroshima Pref., Mr. K. Matsumoto coll., May 20, 1959.

O. The collection in the Usa Marine Biological Laboratory of Kochi University, through the courtesy of Dr. Mitsuaki Nakauchi of the laboratory. A single ind., Uranouchi Bay, before 1963.

P. The collection in the Biological Laboratory, College of General Education, Nagoya University: A single ind., Miya-oshima, Gamagori, Aichi Pref., by dredge, Prof. Takaoka coll., 1948.

Q. The collection made by benthos survey group of Tanabe Bay in the Seto Marine Biological Laboratory. Three inds., respectively at the following stations: Stn. 2, 27.2 m deep, sand mud temp. 15.8°C, Feb. 21, 1978; Stn. 3, 34.5 m deep, mud with shell fragments, mud temp. 14.2°C, Feb. 21, 1978; Stn. 5, 22.3 m deep, mud with shell fragments, mud temp. 24.2°C, Nov. 1, 1977. The last two specimens were described by Nishikawa in 1978.

R. The author's collection. A single ind., off Hosojima Island near Onomichi, Hiroshima Pref., 12 m deep, shell sand, May 27, 1975.

S. The collection of Mr. Hiromichi Imakigi, a graduate student of Kyusyu University. Four inds., between Ainoshima Islet and Koga, Fukuoka Pref., 15 m deep, Nov. 1, 1976.

T. The collection of Dr. Ryonosuke Kitamori. Five inds., off Gobo, Wakayama Pref., ca. 20 m deep, Apr. 1978.

The Outline of the Research History of Japanese Lancelets

The following stories are concerned limitedly with the lancelets found in Japan and indicated by Japanese specific name of "*Namekuji-uo*".

The first finding of lancelets by modern biologists from the Japanese waters was, according to Prof. Kakichi Mitsukuri (Andrews, 1895, pp. 102–103; also see Oka, 1895, p. 133), made in 1881 by Prof. Namie Ishikawa and Mr. Shin'nosuke Matsubara; Ishikawa found some larvae in the plankton samples collected by surface towing near Tomo, Hiroshima Prefecture in summer and Matsubara obtained lancelets by dredge off "Buzen", the northeastern part of Kyusyu, facing the Seto Inland Sea. Since then, many localities of this animal have been recorded in the Japanese waters by many authors (see Table 1 and Figure 1), though many of them have seemingly become to be only the historical records and lost their actual significance at the present day; this may remind the readers of the sudden decrease of "Amphioxus" since the 1930's in the Bay of Naples (Bone, 1958, p. 1).

In taxonomy: Andrews (1895) examined six specimens of "*Namekuji-uo*" collected from Shikanoshima and identified them "provisionally" with *B. belcheri*. Later,

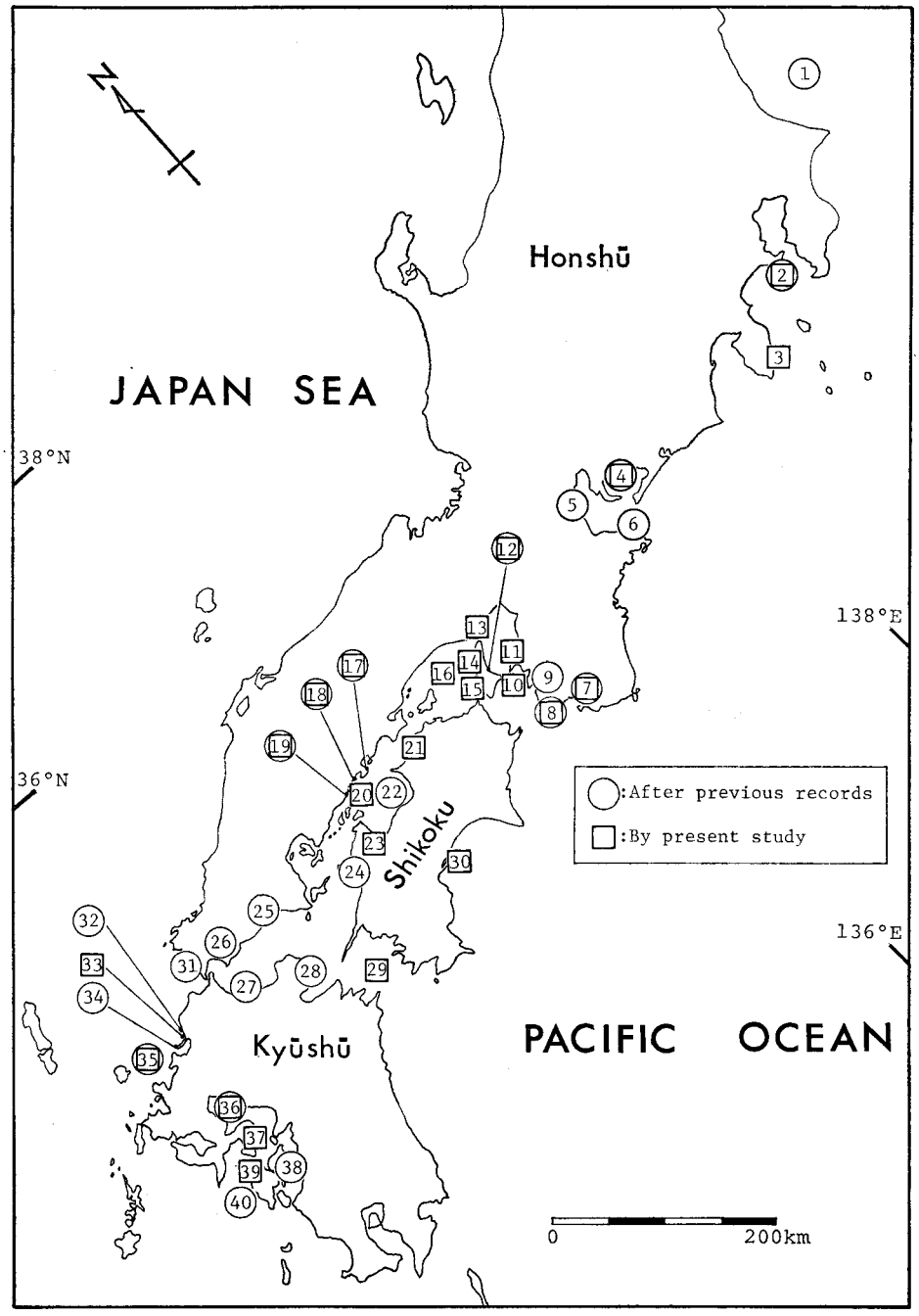

Fig. 1. Localities of "*Namekuji-uo*" in the Japanese waters.

Table 1. Localities of "*Namekuji-uo*" after previous records. For the locality number, see Figure 1.

Locality number	Station of Localities	Depth, nature of floor and etc.	Date of Collection	Sources
1	Off Ibaraki Pref.; 35°58′50″N, 140°50′50″E.	57 m		Okada, 1929
2	Koajiro Bay, Misaki.	12 ftms	June, 1899	Kobayashi, 1979
2	Koajiro Bay, Misaki.	(type specimens of *B. nakagawae*) Kumakichi Aoki coll.		Jordan & Snyder, 1901
2	Off Moroiso, Misaki.	15 ftms, 1 ind.	1932	Shigei, personal information
4	Miya-oshima (Mikawa-oshima), Gamagori, Aichi Pref. *1	Two inds., Takeuchi coll.	Mar. and May, 1968	School Board of Gamagori, 1970
5	Kawage, Mie Pref.	Some ones found washed ashore after heavy storm	June, 1914	Tanaka, 1916
6	Off Toba, Mie Pref.; 35°32′N, 136°52′E.	16 m, sandy mud	1976	Mori, personal information
7	Tanabe Bay	22.3–34.5 m, mud with shell fragments	Nov. 1, '77 and Feb. 21, '78	Nishikawa, 1978
8	Off Gobo, Wakayama Pref.	17.3 m, sand or sandy mud, 6 inds. by bottom sampler (20 cm×20 cm)	Apr. 22, 1978	Wakayama Pref., 1978
9	Yura Bay, Wakayama Pref.	The last collection in 1968		Goto, personal information
12	Sumoto, eastern coast of Awaji Island	Many found washed ashore	Feb. 15, 1912	Tanaka, 1915
17	Around Tomo, near Onomichi, Hiroshima Pref.	Larvae by surface towing	summer of 1881	Andrews, 1895; Oka, 1895
17	Tomo and around Hashiri-jima Island	Ohwatari coll.	Oct., 1909	Yatsu, 1909
17	Tomo, around Hashiri-jima and Sesui-jima Islands	more than 1 ftm, fine sand, found rather densely	Oct., 1909	Kobayashi, 1910
18	Onomichi, Hiroshima Pref.	H. Iijima	Dec. 6, 1900	Yatsu, 1901
19	near Uryu-jima Island (Nouji sand bank), Saizaki, Mihara, Hiroshima Pref. *2	Inhabited rather densely	1938	Sakata, 1939
19	Saizaki, Mihara, Hiroshima Pref.		Mar. and May, '55	Nogusa, 1957
22	Hiuchi-nada, Seto Inland Sea	ca. 50 m		Kikuchi, 1977
24	Gogoshima Island, off Matsuyama, Ehime Pref.	Four inds. by dredge	Aug., 1900	Kataoka, 1900
24	Gogoshima Island.	sandy beach, in the lower intertidal zone, 2 inds. Kataoka coll.	June, 1904	Yatsu, 1904
25	Around Nishinoshima Islet off Tonda, near Tokuyama, Yamagichi Pref.		Apr. 12, 1910	Fujitani, 1910

26	Off Motoyama, near Ube, Yamaguchi Pref.	coarse sand, inhabited rather densely		Kumada, 1936
27	Off "Buzen", Fukuoka Pref., Seto Inland Sea	S. Matsubara coll., by dredge	1881	Andrews, 1895
28	Off "Bungo" (=Ooita Pref.)	S. Matsubara coll.		Jordan & Snyder, 1901
31	Near Shimonoseki, Yamaguchi Pref.	"Prinz Adalbert" Expedition coll. (Berlin Mus. No. 2308)		Franz, 1922
32	Off Tsuyazaki, Fukuoka Pref.	10–25 m		Kikuchi, 1977
34	Near Shikanoshima, Fukuoka Pref.	ca. 10 ftms, 2 inds.	Apr., 1890	Anonym, 1890
34	do.	10–15 ftms, coarse sand, 7 inds.	Aug., 1890	Nakamura, 1890
34	do.	S. Hatta coll.	Apr., 1893	Andrews, 1895
34	do.	Nakagawa coll., by dredge	1892–3?	do.
34	Between Shikanoshima and Tsukuejima Islands	by dredge	Nov., 1894	Ogura, 1895
34	Shikanoshima	12 inds. from stomach content of mackerels	Summer of 1894	Takachiho, 1895
35	North to Shikanoshima; 33°50.2′N, 130°14.2′E.	50 m, 2 inds.	Feb. 6, 1969	Shojima, 1974
36	Ariake Sea, off Tegama, Oomuta, Fukuoka Pref.	on beach at ebb tide, 9 inds. in an hour.	Apr. 1, 1904	Azuma, 1904
36	Takatsu shallow, off the estuary of River Okihata, Yanagawa, Ariake Sea	ca. 100 inds.	Apr. 18, 1927	Ohshima, 1927
36	Ara-tsu and Gando-tsu shallows in the northern part of Ariake Sea	exposed only at the low water of spring tide	spring of 1940	Oyama & Yoshii, 1940
38	Goshono-ura, Amakusa	6–10 ftms, coarse sand, rather densely inhabited	1893–97	Nakagawa, 1897
38	do.	ca. 10 ftms, shell sand	1902?	Tsukiyama, 1902
40	Tomioka Bay, Amakusa			Kikuchi, 1977

*1: This locality, discovered by the late Mr. Kinroku Takeuchi in 1934, was designated by the Government to a natural monument on Mar. 27, 1941. Unfortunately, however, no lancelets were collected during the census surveys that were made in June and December, 1968 and in May, 1969 to learn the state of "*Namekuji-uo*" at the locality in those days (School Board of Gamagori, 1970: A report on the collection survey of "*Namekuji-uo*" around Mikawa-oshima).

*2: This locality was also designated by the Government to a natural monument. According to Mr. Akasaka of the School Board of Mihara (personal communication of Apr., 1977), however, the environment around the Nouji sand bank has been damaged mainly by scooping up of sand in a large scale for commercial purpose and thus this animal can hardly be found at the present.

The author would like to express his hearty thanks to Mr. Harada of the School Board of Gamagori and Mr. Akasaka of the School Board of Mihara, for these important informations.

Nakagawa (1897) examined many specimens from Goshono-ura, Amakusa, recognized that 1) the buccal cirri were invariably about 41 within the range of the body length from 26 to 46 mm (judging from his Table III), 2) the branchial arches increased remarkably with growth within the same range of the body length, and 3) the formula(=arrangement of myotomes) was 36 to 37, 17, 10 to 11 and its variation was "not in accordance with the size of the animal" (ranging from 10.5 to 54 mm long), and concluded on those features that the specimens from Goshono-ura could not be referred to any of the previously known species, though the erection of a new species for these specimens was impossible for lack of sufficient information about the morphological variations in each of the known species. Willey (1897) separated "the Japanese Amphioxus" described by Andrews (1895) from the type form of *Amphioxus belcheri* as a variety that was named by him var. *japonicus* (p. 220, foot note) for the "geographische Merkmale" (Lönnberg, 1901, p. 240), while Jordan and Snyder (1901) erected a new species *Branchiostoma nakagawae* for the specimens from Koajiro Bay, Misaki and included the specimens described by Andrews (1895) and Nakagawa (1897) within this new species. *B. nakagawae* was, however, synonymized with *Amphioxus japonicus* Willey by Lönnberg (1901, pp. 240–241) on the rule of priority. On the other hand, Tattersall (1903), comparing *B. nakagawae* with *B. belcheir* from Ceylon, came to the conclusion that the two species are "really the same" and the former is a junior synonym of the latter which is "merely a variety of *B. lanceolatum*". Jordan, Tanaka and Snyder (1913) referred the Japanese name "*Namekuji-uwo*"(*uwo*=*uo*) to *B. belcheri* inclusive of *B. belcheri japonicus* and *B. nakagawae*. Later both Franz (1922) and Hubbs (1922a) synonymized, in their monographs, all specific names given to Japanese lancelets by the above-mentioned descriptions with *belcheri*. Since then, some of the authors or rather compilers of Japanese books or illustrated catalogues adopted the specific name of *japonicum* for "*Namekuji-uo*" (for instance, Tanaka, 1927; Okada, Uchida and Matsubara, 1935; Tokioka, 1947), while others the name of *belcheri* (or, erroneously, *belcherii*) (for example, Iijima, 1918; Oyama and Yoshii, 1940; Matsubara, 1955; Tokioka, 1965); but these are taxonomically quite insignificant, because they are not specialists about this animal group.

In biology: Only a few biological or ecological studies of "*Namekuji-uo*" have been published up to now. As to the breeding season, Nakagawa (1897) stated as "the period of active egg-laying must be between the middle of June and the end of July" in Goshono-ura, while Oyama and Yoshii (1940) suggested that the spawning season may extend from the end of May to the middle of June in the northern part of Ariake Sea, and further according to Nogusa (1957) the season is May and June in Saizaki, Hiroshima Prefecture. Kumada (1936) reported that 2–5 individuals of "*Namekuji-uo*" were obtained, by every operation of a sampler which could grasp (10 cm^2) of bottom surface, in the Seto Inland Sea off Yamaguchi Prefecture. This is the only quantitative record as to the population density of "*Namekuji-uo*" that ever populated rather densely in various localities in Japan as also seen in Table 1. Kikuchi (1977) revealed recently that the animal inhabits nearly exclusively in

the sand of Mdϕ=0.7–1.5 and So=1.1–1.7, by analysing the collection data at the depth of 10–50 m off Tsuyazaki in Fukuoka Prefecture, and in the Hiuchi-nada, the Seto Inland Sea and Tomioka Bay, Amakusa. The pelagic larvae of the Japanese lancelets were firstly described by Shojima (1974) (see p. 149).

In karyology: Nogusa (1957) recorded, on '*Branchiostoma belcheri*' from Hiroshima, that the haploid chromosomes are 16, this number is larger than that previously known on *B. lanceolatum* (10–12, according to Makino, 1950, pp. 137–138). Recently, however, both of these two records are questioned by Colombera (1974).

In histology: Nakao (1964 and 1965) described the fine structure of the photoreceptor and the excretory organ of '*Branchiostoma belcheri*' from the Japanese waters respectively, Kataoka and Fujita (1974) reported the occurrence of endocrine cells in the posterior part of the mid-gut in the specimens of '*Branchiostoma japonicum*', and Anno and Kawai (1975) investigated the mucopolysaccharides of the connective tissue of '*Branchiostoma belcherii*' from the Seto Inland Sea.

Results of Morphological Observations

The most important part of the morphological observations was occupied by the measurement of respective meristic characters, the results of which as given in Tables 2 and 3. In addution, the following notes seem necessary to make the status of Japanese "*Namekuji-uo*" clear.

1. In nearly all the specimens examined in the present study, inclusive of those from Amoy, the shape of the rostral and caudal fins and the relative position of the anus to the lower caudal fin are very similar; the post-rostral notch is more or less distinct, the caudal fin is rather remarkably distinguishable from the body and the anus is situated nearly at the center of the lower caudal fin.
2. The number of the dorsal and preanal fin-ray chambers seems clearly invariable with the body length, as already shown by Tchang-Si and Koo (1936, p. 83) on *B. belcheri* var. *tsingtauense* from Kiaochow Bay and by Boschung and Gunter (1962, p. 251) on *B. caribaeum* Sundevall from the Gulf of Mexico (for the number of the dorsal fin-ray chambers only). According to Webb (1957, p. 255), however, the preanal fin-ray chambers "increase with the age of the animal" in *B. elongatum* (Sundevall) from Peru. And seemingly no correlation is discernible between the number of the dorsal fin-ray chambers and that of the preanal ones in the specimens examined here.
3. The number of myotomes is also clearly invariable with the body length, as already shown by Nakagawa (see p. 142), and by Boring and Li (1932, p. 11) on *B. belcheri* from Amoy and by Tchang-Si and Koo (1936, p. 81) on *B. belcheri* var. *tsingtauense*.
4. The correlation between the number of buccal cirri and the body length may be seen in Figure 2. Although this figure is composed of the data on the specimens from different localities, it is clearly suggesting that the buccal cirri increase with growth. The statement of Nakagawa on this point was correct within a certain range of body

Table 2. Meristic characters of *B. belcheri* from the Japanese waters. Character numbers 1-11 are: 1, number of dorsal fin-ray chambers; 2, that of preanal fin-ray chambers; 3, ratio of height to breadth of dorsal fin-ray chambers; 4, relative height of total body to dorsal fin; 5, relative length of postatrial region to preatrial region; 6, number of myotomes from anterior end to atriopore; 7, that from atriopore to anus; 8, that posterior to anus; 9, total number of myotomes; 10, total body length (mm); 11, number of examined specimens. Numerals in parentheses

Locality (Number)	Material	1	2	3	4	5
(2) Misaki	K	ca. 200	56, 58, 60	3.3–4.4	7.6–10.4	0.43, 0.45, 0.49
(2) Misaki						
(3) Shimoda	L	290	47	3.7	10.0	0.41
(4) Gamagori	A-1	260–280 274.4±8.82	50–56 51.2±2.68	1.8–2.8	9.8–13.0	0.45–0.50 0.48±0.02
(4) Gamagori	D	310	64	2.5	—	0.49
(7) Tanabe Bay	Q	260, 280, 300	52, 57, 66*	3.5–5.0	7.2–9.5	0.44, 0.45, 0.47
(8) Gobo	T	290–310 298.3±8.37	60–63 61.4±1.34	ca. 5	—	0.43–0.49 0.46±0.04
(10) Jino-oshima	H	280	58	4.0	8.4	0.52
(11) Tanagawa	D	280–326(11) 294.5±15.3	54–66(12) 59.0±4.36	3.5–6.0	7.2–11.0	0.38–0.50(11) 0.46±0.04
(12) Sumoto	B-1	280–350(18) 311.8±25.0	54–66(17) 58.6±4.14	2.3-4.0	8.3–11.5	0.42–0.51 0.46±0.03
(13) Kobe	M	300	64	3.9	—	0.46
(14) Maruyama	G-1	320	59	4.5	10.5	0.46
(15) Fukura	G-3	300	58	5.0	10.0	0.48
(16) Shikanose	E-3	270–320 289.1±15.8	54–66 60.3±4.05	2.5–5.0	8.2–12.0	0.44–0.50 0.47±0.02
(17) Tomo	B-2	260, 305	ca. 50	—	—	0.45, 0.52
(18) Onomoichi	F-1	330	50	2.8	12.0	0.43
(18) Onomichi	E-2	310	58	3.0	10.6	0.45
(19) Mihara	N	330	56	4.0	7.0	0.40
(19) Mihara	A-2	276–310 290.6±10.5	53–68 60.7±4.59	2.3–4.5	8.3–11.6	0.44–0.48 0.46±0.02
(20) Hosojima	R	270	55	3.5	10.4	0.52
(21) Nishiwaki	G-2	290	54	4.5	9.6	0.52
(23) Nyugawa	I	280, 300, 320	50, 52, 58	3.0–3.8	8.0–10.0	0.44, 0.45, 0.47
(29) Bungo Channel	A-3	ca. 280(1)	—	—	—	0.46, 0.51, 0.53
(30) Usa	O	ca. 330	56	3.3	13.5	0.48
(31) Shimonoseki		270	59			
(33) Koga	S	270–300 287.5±15.0	45–60 53.8±6.75	2.8–4.0	10.0–11.0	0.48–0.51 0.49±0.02
(34) Shikanoshima						
(35) Off Shikanoshima	J	280, 300	50, 56	5.5(1)	9.0	0.45, 0.53
(36) Ariake	C-1	280–300(5) 290.0±7.07	56–60(4) 57.5±1.91	2.2–5.0	6.7–10.0	0.42–0.49 0.46±0.03
(36) Ariake	A-4	270–310 292.5±17.1	48–55 50.8±3.00	2.5–3.6	10.0–12.5	0.45–0.48 0.46±0.01
(36) Ariake	A-5	ca. 300(1)	50. 60	1.8, 3.0	9.2	0.47, 0.51
(37) Shimabara	F	265–310 285±16.4	54–61 55.6±2.12	2.6–4.4	7.5–11.2	0.44–0.50 0.46±0.02
(38) Goshiono-rua						
(39) Amakusa	B-3	290, 300	58, 60	4.1, 5.0	6.1, 9.0	0.47, 0.48

in each column of characters indicate the number of specimens that could be actually examined as to respective characters. * This is the corrected number of the preanal fin-ray chambers in Specimen A (Nishikawa 1978, Table 1), that were erroneously given as 74. ** Means and standard deviations were calculated by the present author on the measurements given in the original papers.

6	7	8	9	10	11	Source
37, 38	17, 18	11	65, 67, 68	42.3–52.5	3	by present study
37	16	10–11	63–64	45.5	?	Jordan & Snyder, 1901
38	19	10?	67?	31.8	1	by present study
37–38 37.2±0.47	16–17 16.6±0.55	10–11 10.2±0.45	64	30.7–50.6	5	do.
37	17	10	64	48.2	1	do.
39–40	17–19	9, 11	67, 69	29.7–39.8	3	do.
38	18(4)	10–11 10.4±0.55	66–67(4) 66.3±0.51	14.8–19.6	5	do.
38	17	11	66	24.7	1	do.
38–39(11) 38.8±0.41	17	10–11(11) 10.9±0.30	66–67(11) 66.7±0.47	10.8–30.5	13	do.
37–41(18) 38.4±0.98	16–18(18) 17.2±0.55	9–12(18) 10.6±0.70	64–69(18) 66.3±1.49	36.2–57.3	19	do.
39	17	12	68	16.0	1	do.
39	17	10	66	35.0	1	do.
38	17	11	66	14.1	1	do.
38–39 38.6±0.51	17–19 17.5±0.69	10–11 10.9±0.30	67	29.7–39.8	11	do.
—	—	—	—	—	2	do.
41	16	9	66	54.5	1	do.
38	17	10	65	52.5	1	do.
39	17	11	67	39.0	1	do.
37–39 38.2±0.42	17–18 17.4±0.52	10–11 10.9±0.32	66–67 66.5±0.53	24.7–56.4	10	do.
38	18	9	65	43.1	1	do.
38	18	10	66	25.8	1	do.
39	17	11	67	44.0–49.1	3	do.
38, 39	17	9, 10, 11?	65, 66	14.7–27.6	3	do.
38	18	10	66	37.0	1	do.
39	17	9	65	10.0	1	Franz, 1922
37–38 37.6±0.55	17	10–11 10.5±0.58	65	31.7–43.8	4	by present study
37	16	11	64	29.5–46	6	Andrews, 1895
38, 39	17	11	66, 67	13.6, 19.3	2	by present stydy
36–37 36.8±0.41	17	10–11 10.5±0.55	63–65 64.3±0.82	27.5–40.7	6	do.
37–39 37.8±0.96	16–17 16.8±0.50	10–11 10.8±0.50	64–67 65.3±1.26	38.3–47.5	4	do.
37, 38	16, 17	9?, 11	64	39.5, 42.6	2	do.
36–38 36.9±0.57	17–18 17.1±0.32	10–11 10.6±0.52	64–65 64.6±0.52	29.0–46.6	10	do.
35–38 36.5±0.68	16–18 17.0±0.49	9–12 10.6±0.58	62–66 64.1±0.74	10.5–54.0	58	Nakagawa, 1897**
36, 38	17	10	63, 65	37.5, 46.5	2	by present study

Table 3. Meristic characters of *B. belcheri* and *B. belcheri* var. *tsingtauense* (***) from foreign

Locality (Material)	1	2	3	4	5
Kiaochow Bay***	284–363(25) 320.8±17.5	51–73(20) 60.6±4.90			
Amoy (A-6)	300–330 313.8±13.4	68–91 80.6±6.40	2.0–3.5	9.5–13.0	0.44–0.50 0.46±0.02
Amoy? (A-7)	290–340 311.1±13.6	65–90 80.8±6.92	2.0–3.6	9.5–16.0	0.43–0.53 0.50±0.03
Amoy? (A-8)	300–330(24) 312.5±11.1	70–92(27) 79.3±5.60	2.0–3.2	9.5–12.0	0.39–0.54 0.49±0.03
Amoy (B-4)	320–340 330.0±10.0	80–87 82.6±2.97	2.6–3.0	10.0–14.0	0.46–0.50 0.47±0.02
Amoy (C-2)	300–320 312.0±11.0	76–90 83.6±5.55	2.7–4.0	11.0–15.0	0.42–0.48 0.46±0.03
Amoy					
Amoy	305–338(14) 321.2±11.5	76–94(40) 83.4±4.90			
Amoy	262–393? 313	35–90 72			
Amoy	250–340 305±23.64	67–90 78.1±5.26	2.5–3.5 2.96±0.31	7–11 9.08±0.96	0.42–0.54 0.50±0.024
Prince of Wales Island, Torres Strait					
Borneo (type locality)					
Bedok, Singapore	340	90	3.0	9.0	0.47
Mergui Archipelago, Andaman Sea					
Ceylon					
Ceylon					
Tuticorin, India					
Off Coilpaton, India					
Tholayiran par, India					
Bagamoya, Tanzania	275	ca. 70			
Nosy-bé, N.W. coast of Madagascar	280	65	3–4	8	0.4
Linga-linaga, Mosambique	258–306 287.0±15.5	70–88 80.6±5.61	3.0–3.6 3.17±0.24	7–10 8.8±0.97	0.43–0.47 0.45±0.012
Off Mosambique Is., Mosambique	276	68	4.0	8	0.46

length (see p. 142). It may be, however, rather natural that the correlation pattern varies somewhat according to different localities. The increase of the buccal cirri with growth has been also demonstrated by Boring and Li (1932, p. 14) on *B. belcheri* from Amoy, by Tchang-Si and Koo (1936, p. 81) on *B. belcheri* var. *tsingtauense* from Kiaochow Bay and by Boschung and Gunter (1962, p. 253 and Fig. 20) on *B. caribaeum* Sundevall from the Gulf of Mexico. The conical papillae on the cirrus are almost always discernible, though the degree of their development is irregular; this is partly attributable to the epidermal deterioration in preservation.

5. The wheel organ consists usually of four rods on each side, though the number

localities. For signs, see Table 2.

6	7	8	9	10	11	Source
37–40(150) 38.8±0.46	16–18(160) 17.7±0.50	10–12(150) 10.6±0.54	65–69(150) 67.1±0.67	–55		Tcahng-Si & Koo, 1936**
36–38 36.9±0.52	16–18 17.2±0.56	10–11 10.7±0.49	64–66 64.7±0.59	36.2–45.4	15	by present study
36–38 36.9±0.40	17–18 17.4±0.49	10–11 10.3±0.48	64–66 64.6±0.72	28.0–43.4	30	do.
36–38(29) 37.0±0.33	17–18(28) 17.3±0.46	10–11(28) 10.8±0.39	64–66(28) 65.1±0.53	22.5–43.7	30	do.
35–36 35.8±0.48	16–17 16.6±0.55	9–11 10.0±0.71	63–64 63.4±0.55	34.5–40.3	5	do.
36–37 36.4±0.55	17–18 17.4±0.55	10–11 10.8±0.45	64–65 64.6±0.55	37.8–41.3	5	do.
36–37 36.8±0.44	16–18 17.1±0.44	9–11 10.2±0.44	63–65 64.0±0.22	35.5–47.0	41	Boring & Li, 1932**
34–38(112) 36.4±0.64	16–19(112) 17.3±0.58	10–12(112) 10.9±0.52	62–66(112) 64.7±0.74	–48		Tchang-Si & Koo, 1936**
36–39 38	16–18 17	9–11 10	63–65 64	–57	?	Chin, 1941
35–38 36.5±0.82	15–18 17.0±0.76	9–11 10.0±0.54	62–65 63.56±1.0	20–46	25	Webb, 1956c
37–38	16–17	10	63, 65		4	Kirkaldy, 1895
37	14	13	64		1	Günther, 1884 (cited from Tattersall, 1903)
37	19	10	66	44	1	Webb, 1956a
37–38	17–18	9–10		–52	11	Prashad, 1934
36–39 37.9±0.73	16–18 17.1±0.42	8–10 8.95±0.48	63–66 63.9±0.70	26–56	55	Tattersall, 1903**
37–38 37.4±0.58	16–18 17.0±0.71	9–10 9.40±0.55	63–65 63.8±0.84	47–56	5	Franz, 1922**
37–38 37.3±0.73	17–19 17.4±0.84	9–10(7) 9.43±0.54	63–66(7) 64.3±1.00	27–47	9	Franz, 1922 **
37	17	10	64	20–45	?	Prashad, 1934
37	17	9–10	63–64	30–35	4	do.
38	16	9	63	26	1	Franz, 1922
37	17	9–10	63–64	43–52	4	Massé, 1964
36–39 37.1±0.79	17–19 17.7±0.71	9–11 9.9±0.60	63–66 64.7±1.12	42–48	9	Webb, 1957
34	17	11	62	62	1	do.

and shape of rods may vary slightly. This structure cannot be always observed, probably partly for some artificial causes.

6. Figure 3 shows the relation between the number of gonads on each side and the body length, basing on the two lots of specimens from Japan and the same number of lots from Amoy. These four lots were selected, because the specimens in them seemed to hold the complete series of gonads on each side; the gonads are usually found partly injured or lost in many specimens. This figure seems to suggest the following points:

   a. Any correlation is hardly discernible between the number of gonads and

the body length so far as this figure is concerned.

b. In each specimen, the number of gonads may, if not all, be larger on the right side than on the left by 1 to 3; the same trend may also be seen in the

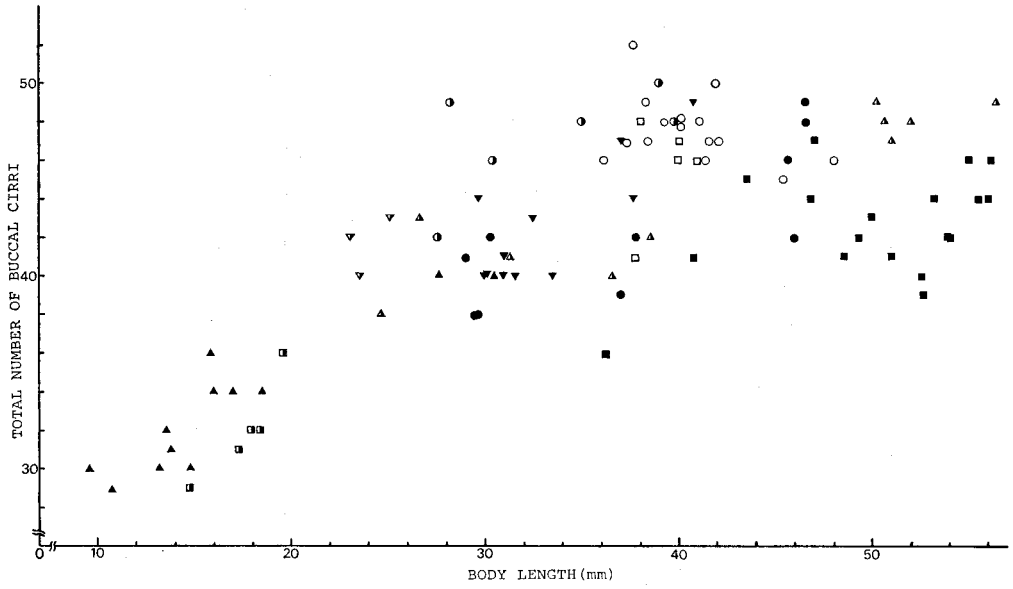

Fig. 2. Correlation between the total number of buccal cirri and the body length in the specimen lots of *B. belcheri* from Tanagawa (Material D: solid triangle), Shikanose (E-3: inverted solid triangle), Sumoto (B-1: solid square), Gobo (T: semi-open square), Tanabe Bay (Q: inverted semi-open triangle), Mihara (A-2: semi-open triangle), Shimabara (F: solid circle), Ariake (C-1: semi-open circle), and Amoy (A-6: open circle and C-2: open square).

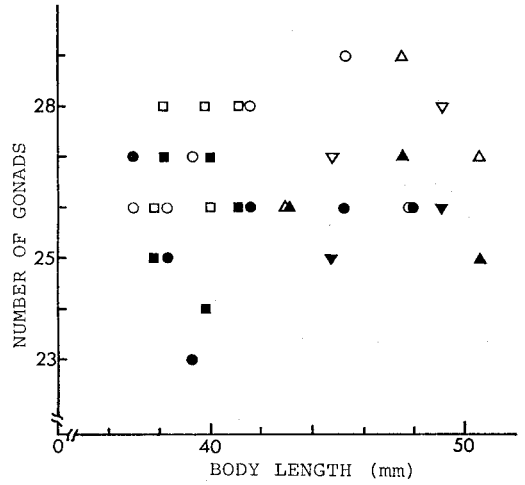

Fig. 3. Relation between the number of gonads and the body length. The number of gonads seemingly in complete series is plotted here, basing on the specimen lots from Gamagori (Material A-1: triangle), Ehime (I: inverted triangle) and Amoy (circle for A-6 and square for C-2). Solid for the number of gonads on the left side and open for that on the right.

specimens of *B. belcheri* from Amoy (Chin, 1941, p. 373 and Tchang-Si and Koo, 1936, p. 86) and India (Prashad, 1934), and in *B. belcheri* var. *tsingtauense* from Kiaochow Bay (Tchang-Si and Koo, 1936, pp. 82 and 86). The number of gonads itself may be rather constant throughout the whole specimens examined in the present study.

7. The smallest individual with seemingly matured gonads in the present material is a 27.6 mm long specimen from Bungo Channel, this is lightly smaller than the 29 mm long specimen "with full-grown gonads" from Amoy (Chin, 1941, p. 372), but larger than the 25 mm long one with "full-sized gonads" from Amakusa (Nakagawa 1897, p. 127).

From what are seen in Table 2 and the above-mentioned additional features, it seems that no significant differences exist among the examined specimens from the Japanese waters, except in the total number of myotomes. In this character, the specimens from Ariake, Shimabara and Amakusa may possibly be distinguished from those from other localities except Gamagori (Locality No. 4). Roughly speaking, total myotomes are 64–65 on an average in the specimens from Ariake, Shimabara and Amakusa, while 66–67 in the specimens from the other Japanese localities. In this respect, the specimens from Amakusa treated in the present study are seemingly corresponding to those previously measured by Nakagawa (1897). On the other hand, the measurements of the specimens from Misaki and from around Shikanoshima in the present study clearly do not agree with the previous measurements given by Jordan and Snyder (1901) and Andrews (1895) on the specimens from the same locality. This makes the problem very confused and seemingly makes the above-mentioned difference in the number of total myotomes insignificant. The number of myotomes or other segmental structures may be more or less influenced by water temperature in some stages during the development as seen in the variation in the number of vartebrae in some teleosts that was demonstrated by Hubbs (1922b, 1924, 1926 et al.) and many others (see, for example, Fowler, 1970; Ali and Lindsey, 1974). The number of myotomes might possibly fluctuate with the water temperature, and thus naturally according to different localities and even from year to year at the same locality. Further crucial analyses of this problem must be retained for future studies. As to this problem, refer also the suggestion of Wickstead on the possibility of increase of myotomes in pelagic larvae (see p. 152).

The specimens from Amoy examined in the present study are similar, in nearly all the characters checked, to those of *B. belcheri* previously recorded as seen in Table 3.

Pelagic Larvae

Fifteen pelagic larvae of lancelets were found in the plankton samples collected during the plankton survey made by the Seikai Regional Fisheries Laboratory mainly around Kyusyu; all the samples were obtained by towing in the surface 0–164 m layer above the floor 112 to 2,080 m deep (Shojima 1974, table 1). These

Table 4. Collection data after Shojima (1974) and meristic characters of "giant larvae" from the Japanese waters. The meristic characters are: 1, number of dorsal fin-ray chambers; 2, number of myotomes from the anterior end to anus; 3, number of myotomes posterior to anus; 4, total number of myotomes; 5, body length (mm); 6, number of gill slits.

Specimen Number	Site of occurrence	Date	Depth	Layers towed	Surface Temp.	meristic characters					
						1	2	3	4	5	6
1	36°21.5′N, 131°14.0′E	Nov. 21, '72 1724–1734	>1,000	0	17.2°C	180	53	13	66	7.4	ca.30
2	35°01.5′N, 129°31.5′E	Oct. 27, '73 0750	<200	0–72	20.9	300	58	13	71	8.2	30
3	34°23.0′N, 130°00.0′E	Nov. 10, '73 0848	113	0–110	21.0	200	56	16?	72?	7.0	26
4	34°39.5′N, 129°07.5′E	Oct. 27, '73 0230	<200	0–137	20.7	260	68	12	80	8.3	—
5	33°50.4′N, 129°03.6′E	Nov. 8, '72 2050	112	0–112	22.2	200?	56	12	68	6.9	—
6	33°42.5′N, 129°10.0′E	Nov. 8, '72 2216	123	0–123	22.1	310	56	11	67	7.0	29
7	32°18.5′N, 128°29.0′E	May 25, '72 0434	350	0–135	20.0	100	56	11	67	6.6	—
8	32°05.9′N, 128°45.0′E	Feb. 17, '73 0124	330	0–79	18.5	336	58	11	69	8.2	25?
9	31°38.4′N, 130°00.1′E	Feb. 11, '70 0051–0112	163	0	18.7	256	54	13	67	7.0	25?
10	31°30.7′N, 128°29.1′E	Mar. 6, '74 1323–1334	520	0–46	18.6	200?	56?	11?	67?	7.3	26?
11	31°29.8′N, 128°29.8′E	Nov. 24, '69 0750–0800	560	0	22.2	320	55	13	68	8.2	28
12	31°12.8′N, 128°51.3′E	Mar. 6, '74 1916	690	0–117	17.3	200	50	16	66	7.2	25
13	30°54.0′N, 129°09.5′E	Feb. 11, '69 0305–0339	790	0–43	17.2	150?	49	13	62	6.5	25?
14	30°51.6′N, 130°28.0′E	Mar. 1, '69 1900	260	0–147	17.2	170	53	13	66	7.0	—
15	25°49.5′N, 125°19.2′E	Dec. 10, '67 0640	2,080	0–164	23.1	300	67	17	84	10.3	24?

larvae that were once examined by Shojima (1974), were offered by his courtesy to the present author for further microscopical re-examination. The meristic characters thus cleared are given in Table 4.

The larvae are 6.5 to 10.3 mm long and with 25 to 30 gill slits. Comparing their body length and the number of gill slits with those of the previously described larvae of *B. belcheri, B. belcheri* var. *tsingtauense* and other species (see Lou, 1936, Bone, 1957, Wickstead and Bone, 1959 and Wickstead, 1975), these larvae may safely be defined as the "giant larva" that was ever named "Amphioxides" (for this, see

Wickstead, 1964 and 1975). Their morphological features are as follows:

Mouth on the left side and without any cirri; dorsal fin only in the posterior part of body; caudal fin fan-shaped as previously described; dorsal fin-ray chambers, in many specimens, discernible only in the posterior part of body; preanal fin-ray chambers nearly indiscernible in the majority, though a few ones barely discerned in the specimens Nos. 2, 6 and 15.

Figure 4 shows the correlation between the total number of myotomes and the body length, while figure 5 shows the relation between the number of gill slits and

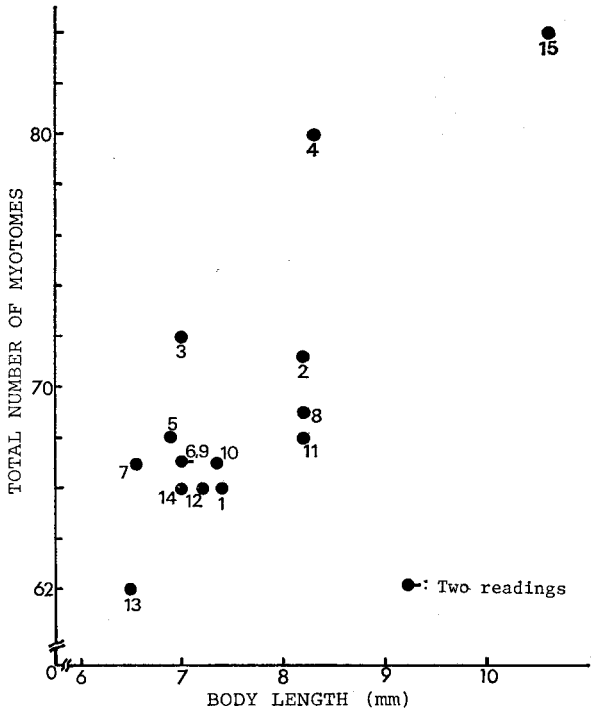

Fig. 4. Correlation between the total number of myotomes and the body length in "giant larvae". For specimen numbers, see Table 4.

the body length. The latter includes not only the measurements obtained in the present study but also those on the larvae of *B. belcheri* from Singapore (Wickstead and Bone, 1959) and the larvae of *B. belcheri* var. *tsingtauense* from Cheefou (=Tchéfou), Pohai Sea, China, that were provided with 56 preanal myotomes (Lou, 1936). Figure 5 suggests clearly some inter-specific trend in the correlation concerned, that is shown by Wickstead (1964, fig. 1 on p. 202). Of the examined larvae, those with 62 to 69 myotomes may probably be referrable to the "giant larvae" of *B. belcheri* (or var. *tsingtauense*). It is not impossible, however, that these larvae are assignable to "*Amphioxides pelagicus*", the accepted "giant larvae" of *Asymmetron lucayanum* with 58 to 71 myotomes, though the former are distinguishable from the latter only by their dorsal fin-ray chambers generally poorly developled. Wickstead

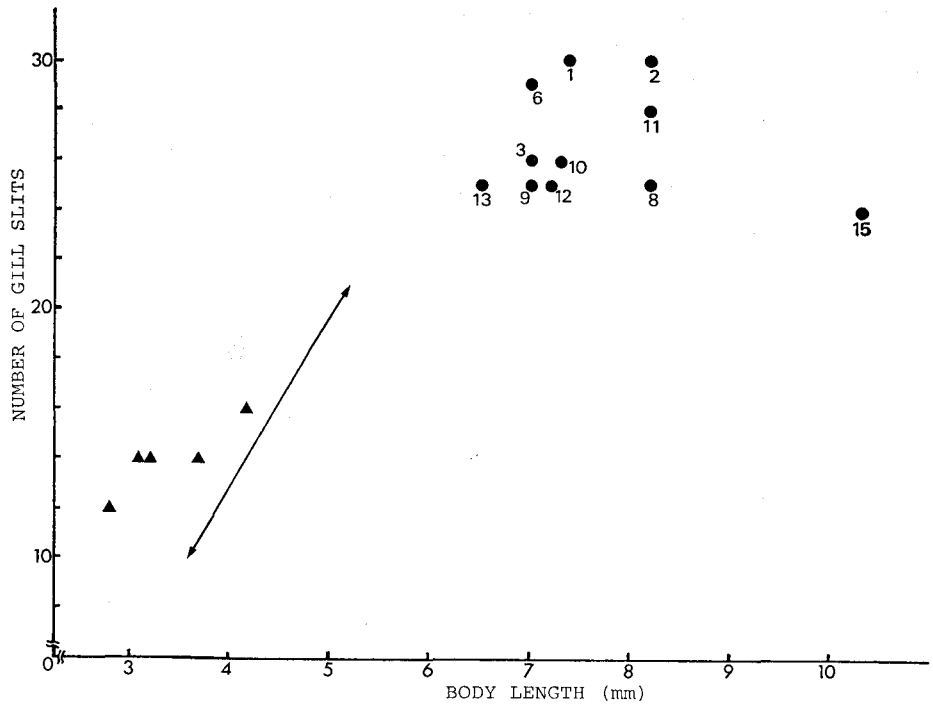

Fig. 5. Relationn between the number of gill slits and the body length, based on the measurements of the larvae examined in the present study (soild circle) and the measurements previously given by Lou (1936) on the larvae of *B. belcheri* var. *tsingtauense* from Cheefou (solid triangle) and by Wickstead and Bone (1959) on the larvae of *B. belcheri* from Singapore (indicated by an arrow showing only the range of the two variates).

(1964) suggested that "adults developed from giant larvae will differ slightly from adults developed from small larvae due to the development in the giant larvae of adaptations for a prolonged pelagic existence, e. g. a slight increase in the post-anal myotome number" (p. 206). If the myotomes increase to a certain extent in the pelagic life beyond the last stage of the "normal" development, the specimens with 71 and 72 myotomes found in the present larvae might also be assignable to *B. belcheri* or some other species. Further, according to the number of myotomes, these larvae might be assignable to *A. maldivense* with 69–75 myotomes, and the specimens with 80 and 84 myotomes in the present larvae to *A. hectori* ever recorded only from New Zealand and with 84–85 myotomes. Anyhow, it is urged to collect much more pelagic larvae, normal or giant, in the Western North Pacific in order to make it possible to identify the pelagic larvae exactly.

Parasite

A nematod was found strongly coiling between the right series of myotomes and the pharynx of the 19.3 mm long specimen from off Shikanoshima, 50 m deep; this is seemingly the first record of the nematod parasitic to the lancelets.

Taxonomic Status of "Namekuji-uo"

All the features mentioned above or given in Tables 2 and 3, may be summarized taxonomically in the following three points:

1) In the number of total myotomes, the specimens of "*Namekuji-uo*" from Ariake, Shimabara and Amakusa on the west coast of Kyusyu Island are related very closely to the previously described typical form of *B. belcheri*, while most of the specimens from the localities in the Japanese waters other than Ariake, Shimabara Amakusa are very similar to *B. belcheri* var. *tsingtauense*.
2) In the number of preanal fin-ray chambers, all the specimens from the Japanese waters resemble closely *B. belcheri* var. *tsingtauense*.
3) In the other characters, the specimens examined in the present study are, in general, similar to the previously described specimens of both *B. belcheri* and its var. *tsingtauense*.

Then, the following conclusion may safely be deducible that "*Namekuji-uo*" in the Japanese waters except those from Ariake, Shimabara and Amakusa on the west coast of Kyusyu Island may be identified with *B. belcheri* var. *tsingtauense* recorded from Kiachow Bay, North China, while those inhabiting along the coasts of Ariake, Shimabara and Amakusa are seemingly reprsenting an intermediate form between this variety and the stem form of the species. Although the decisive taxonomic status of such "intermediate" forms is still pending, it is very possible that var. *tsingtauense* may be definable but inseparable distinctly from the type form of *B. belcheri*. Under these circumstances, "*Namakuji-uo*" may be referred, at present, to *B. belcheri* (Gray, 1847); *nakagawae* and *japonicum* being treated as the synonyms of *belcheri*.

Of the twelve species of *Branchiostoma* recorded from the Indo-Pacific, *B. bazarutense* Gilchrist from Mosambique, *B. tattersalli* Hubbs from Ceylon and Madras and *B. minucauda* (Whitley) from Queensland, Australia, can hardly be distinguished from both *B. belcheri* and *B. belcheri* var. *tsingtauense* on the data respectively given by Gilchrist (1923), Azariah (1965) and Whitley (1932). *B. lanceolatum* is seemingly, however, distinguished, though not very clearly, from *B. belcheri* according to the measurements given by Webb (1956b, 1957), especially by its smaller number of both the total myotomes and the dorsal fin-ray chambers. Nevertheless, the opinion of Tattersall (see p. 142) may still be worthy of re-examination from various points of views and on further specimens from much more different localities in the world seas.

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P.S.: The following important paper reached the author after the manuscript had been sent to the editorial board of the journal.

Carandang, N.C. (1978). The lancelets (Cephalochordata, Amphioxi) of Lucena Anchorage, Quezon, Philippines. Kalikasan, 7 (2): 177–186, 2 tabls., 3 figs.

In this paper, measurements are given on 191 specimens of *B. belcheri* collected in 1969–72 from the intertidal or immediate subtidal zone of Lucena Anchorage, Quezon, and they are summarized as follows: 1,266–398 (321.09±20.66); 2,44–111 (81.76±10.44); 3, 2.0–7.0 (3.84±0.95); 4, 2.5–18.3 (11.20±?); 5, 0.35–0.67 (0.46±0.048); 6, 30–44 (38.16±2.59); 7, 11–21 (16.54±1.20); 8, 7–13 (10.32±1.35); 9, 50–75 (64.89±4.22); 10, 15–46; for 1–10, see the explanation of Table 2.

This datum is seemingly considerably different in several characters from the previous records given in Table 3, and to be noticed from the viewpoint of the geographical variation in this species.